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State Form 4336

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

TECHNICAL MEMORANDUM

Date: April 20, 2007

To: 3B File; Lusher Street
Groundwater Contamination Site
Elkhart County
Elkhart, Indiana

Thru: Gabriele Hauer

From: Mark Jaworski

Subject: Technical Memorandum
Hazard Ranking System Documentation Record
Lusher Avenue Groundwater Contamination Area

Attached is a Technical Memorandum from Paul Giesting from IDEM's Geological Services. This Technical Memorandum was written in response to my request to conduct a review of existing literature and primary geological records that would be available for the Lusher Avenue Groundwater Contamination Area. I have read and approved this memorandum.

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

TECHNICAL MEMORANDUM

DATE: April 25, 2007

TO: Mark Jaworski
Site Investigations

THROUGH: Larry Studebaker

FROM: Paul Giesting
Geological Services

SUBJECT: Hazard Ranking System Documentation Record
Lusher Avenue Groundwater Contamination Area
Elkhart, Elkhart County
(no site number assigned)

In response to your request, I have conducted a review of the existing literature and primary geological records available for the Lusher Avenue Groundwater Contamination Area. I have the following comments:

STUDY AREA

The study area is defined by the St. Joseph River on the north, Hively Street on the south, Oakland Avenue on the east, and Nappanee Street/Indiana Route 19 on the west. The area so defined includes the part of Township 37 North, Range 5 East, Section 7 south of the St. Joseph River and the northern half of Section 18; Lusher Avenue is situated along the dividing line between these congressional sections (USGS, 1994).

REGIONAL BACKGROUND

The St. Joseph Aquifer system is the one that has been contaminated by the hazardous materials in the Lusher Avenue Ground Water Contamination area (IDNR, 1987, pp. 43, 45 and plate 2). This aquifer system consists of Quaternary deposits laid down by glaciation, with the modern surface shaped by the convergence of continental glacial lobes from the northwest (Lake Michigan lobe) and northeast (Saginaw and Erie lobes).

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The St. Joseph River flows in the eastern extension of the Kankakee Lowland outwash plain, a major southwestward outlet for meltwater from the Lake Michigan, Saginaw, and Erie glacial lobes. This outlet was active while the eastern Great Lakes and the St. Lawrence River were still icebound (IDNR, 1987, p. 12; USGS, 1992, p. 20). This plain is mainly underlain by outwash sand and gravel with some Holocene alluvium deposits on top of the sand and gravel and some muddy lacustrine sediments beneath (or within; IDNR, 1987, p. 12) the transmissive zone. Because of the thick deposits of transmissive aquifer material and the relatively high precipitation rate of the Great Lakes region, the St. Joseph Aquifer system is capable of producing over 1000 gallons per minute from properly constructed wells (IDNR, 1987, pp. 44-45).

HYDROSTRATIGRAPHY OF STUDY AREA

Stratigraphy of the Unconsolidated Section

Indiana was eroded to a Paleozoic bedrock surface called the Lexington peneplain (Wayne, 1956, p. 18), which was rejuvenated before the onset of Quaternary glaciation. This rejuvenated surface was deeply eroded by stream valleys, such as the buried south-to-north valley just west of Elkhart (Wayne, 1956 p. 26, 34-35; USGS, 1981, pp. 9, 12-14). Some volumetrically minor paleosols and relic stream channel sediments of Pliocene age may remain between the old bedrock surface and the deepest glacially deposited sediments.

The vast bulk of the unconsolidated material overlying bedrock in the northern two-thirds of Indiana is glacially derived. In the Elkhart area, most of this glacial material is coarse-grained, although some fine-grained till is also observed within the unconsolidated section. Published sources are silent on the subject of stratification of these deposits by age. In other parts of Indiana, attempts have been made to create a stratigraphic column for the Pleistocene section with assignments made to the Kansan, Illinoian, and Wisconsin glacial advances (examples in ref. Wayne 1956, pp. 58-64), but these interpretations are difficult to substantiate. Deep glacial stratigraphy in Indiana is an area of current research, but results have not been published for Elkhart city and county (Kim Greeman, USGS, retired, pers. comm. 4/11/2007 and 4/13/2007; Marni Karaffa, Indiana Geological Survey, pers. comm. 4/16/2007). No attempt is made in this document to divide the Pleistocene section in Elkhart by age, but it is expected that the entire section was laid down during multiple glacial stages or substages. The

cross-section in USGS (1981), p. 14, and water well logs available from the IDNR (2007a) suggest deposition of the unconsolidated section by several discrete events.

Near the St. Joseph River and other streams, Holocene alluvial deposits are overlain upon the Wisconsin surface. These deposits are not extensive compared to the Pleistocene section. Mass wasting processes have not had a significant effect on the stratigraphy of the study area during the Holocene. Glacial outwash is usually overlain by a veneer of topsoil less than 1 foot thick in the Elkhart area (USGS, 1981, p. 15).

All study area-specific information regarding stratigraphy is derived from IDNR water well records (IDNR, 2007a). IDNR well record number 378988 provides a typical example of the structure of that portion of the aquifer in which water wells are screened in the study area. The driller's log records a surface layer of sand and gravel, followed by a thin (3 feet thick) clay layer, then gravel, another thin clay layer, sand, "rice gravel", and more sand. This sequence is typical of the study area in that it includes discrete layers of sediments with widely varying hydraulic conductivities. The order in which these layers appear, however, is not reproduced and varies widely across the area. The process of glacial ablation, which gives rise to outwash sediments, introduced significant spatial randomness during the deposition of sediments in this particular area as meltwater laid down successive discrete channels, ribbons, and sheets of outwash composed of materials with differing transport and processing histories. The result is an aquifer with a wide array of discrete channels with very high hydraulic conductivities (gravels, often logged as "vein" on water well logs) coexisting with saturated regions with far lower conductivities (sands, especially fine sands) and other saturated regions with trivial conductivities (clay and silt tills) that form a relative barrier to water and contaminant transport.

Thick clay deposits occur in the Elkhart area and, where laterally continuous and extensive, produce a two-aquifer system with an upper unconfined and a lower confined aquifer. Using data from available IDNR well logs, the Indiana Geological Survey (IGS) has prepared a database (iLITH) recording the thickness of different unconsolidated strata throughout Indiana (IGS, 2007b). This allowed the preparation of Figure 1, which presents estimated thicknesses of the confining clay layer in the Lusher Avenue Groundwater area. A band where the

clay layer is interpreted as thin or absent crosses the study area from its southwest corner at Hively and Nappanee across the site to its east side at Indiana and Oakland.

To confirm this interpretation, four geological cross-sections were prepared based on available well logs for T. 37 N, R. 5E, sections 7 and 18 (IDNR, 2007a). The surface traces of the cross-sections are displayed on Figure 2 and the cross-sections are presented as Figures 3, 4, 5, and 6. The wells whose logs were used to construct the cross-sections are marked with vertical lines and their IDNR well record ID numbers are indicated on the sections. Some of the well logs were located via an IDNR GIS database (IDNR, 2007b); these wells have IDNR well record ID numbers 60321, 60326 (on Cross-Section A-A') and 60311 (on Cross-Section B-B'). All other wells were located by referring to the address or driving directions on the IDNR well record and consulting the Orthophotos GIS collection (IGS, 2007a); the location was assumed to be within a building at the address described. Surface elevations for the wells were retrieved from the well record when present. Otherwise, an elevation was estimated using the USGS 7.5 minute quadrangle for Elkhart, Indiana (USGS, 1994). The dominant elevation features in the study area are the St. Joseph River valley and the elevated railroad tracks leading to the adjoining Norfolk Southern (former Conrail, former Penn Central) Elkhart Railyard. In an effort to include as much data as possible, wells up to approximately 300 feet off the section traces were plotted on the sections.

Cross-Section A-A' (Figure 3) illustrates that the clay layers beneath the northeast section of the Lusher Avenue Groundwater Contamination Area are thin and discontinuous over long distances. Cross-Section B-B' (Figure 4) depicts a relatively thick, continuous aquitard overlying the northwest section of the study area. As noted on the figure, the gap in the aquitard at well 60970 may be due to the location of this well east of the section trace, and the aquitard may be continuous across the entire section. However, the aquitard splits and the upper layer becomes thin in the southern portion of the section. Cross-Section C-C' (Figure 5), which continues Cross-Section A-A', illustrates two laterally extensive aquitards near Lusher Avenue on the east side of the study area, which would present barriers to vertical flow of water or DNAPLs. The deeper layer was not probed by logged wells. Cross-Section D-D' (Figure 6), which covers the western portion of the study area, shows only one clay layer (at higher elevation than any

clay layer seen on Cross-Section B-B' and probably discontinuous with them), which pinches out approximately under Lusher Avenue.

Some wells were not placed on a cross-section and are discussed here individually. Two wells located north of 18th and Lusher (159032, 159041) show clay layers less than 10 feet thick. Clay is logged for two nearby wells (60296, 60301), but the logs are faulty and the thickness cannot be determined from them. One shallow well northeast of 17th and Lusher (60331) shows no clay layer to a total depth of 38 feet. Two wells located north of Hively Street (60285, 60290) have logs that show a clay layer between 47 feet and 68 feet below ground surface. Two wells located south of Hively Street, just out of the study area (60284, 60289) have logs that show a clay aquitard at 26 and 25 feet below ground surface, extending to 42 and 50 feet below ground surface respectively. The log for 60284 also shows a deeper clay layer at 69 to 84 feet below ground surface. Thus, there are substantial clay layers in this part of the site, but as is often seen elsewhere, they are not found at consistent depths and may not be laterally continuous.

Overall, the well logs that were examined confirmed the iLITH data in Figure 1. Note that in the northeast portion of the study area (Cross-Section A-A', Figure 3) the iLITH data show a significant thickness of clay, but the cross-section reveals this clay to be surficial. It does not separate the aquifer into an unconfined and a confined portion as is the case in the northwest area.

Stratigraphic Effects on the Potential for Contaminant Transport

Based on the information presented, the sand and gravel aquifer used by residential and commercial wells in the Lusher Avenue Groundwater Contamination area is semiconfined, in the sense that only limited portions of it are confined, and unconfined portions of the aquifer are always nearby. Any DNAPLs that may be confined to the upper aquifer in the southeast portion of the area have the potential to spread downward in the unconfined northeast region, since local groundwater is generally accepted to flow north toward and into the St. Joseph River (USGS, 1981, p. 25; IDNR, 1987, p. 43; Ecology and Environment, 1994, Figures 3-4, 3-5, and 3-6). Likewise, DNAPLs from a contaminant source in the southwest portion of the area may have sunk below the level of the aquitard(s) in the northwest area, which may have resulted in contamination in the lower aquifer as well as the upper aquifer.

This aquifer is capable of supporting an extensive plume of contaminated groundwater. The shape of the plume will be governed strongly by local heterogeneities such as banks of clay, around which the plume must split horizontally or vertically, and local channels of highly transmissive gravel, through which the plume will migrate rapidly downgradient. A large-scale example of such a diversionary phenomenon is the split of groundwater from the Conrail Railyard Superfund Site into two plumes horizontally around a large bank of clay (Chirlin and Associates, 1996, pp. 5-8). A systematic network of soil borings and nested monitoring wells will be required to delineate a plume in the Lusher Avenue Groundwater Contamination Area and identify its source.

Bedrock

The Ellsworth Shale forms the lower boundary of the St. Joseph Aquifer underneath the study area. Similar bedrock formations underlie the entire Indiana portion of the St. Joseph River basin (IDNR, 1987, pp. 15-16).

The Conrail Railyard Superfund Site adjoins the study area to the west. Bedrock was encountered in several boreholes drilled during investigative activities at this site, and in all cases the bedrock was observed to be dense and dry (Ecology and Environment, 1994, p. 3-3). The shale is likewise believed to be an aquiclude within the study area, and no water wells are known to be screened within it or below it in the study area from IDNR well records.

SUMMARY

The aquifer beneath the Lusher Avenue Groundwater Contamination Area is composed of a thick series of outwash sand and gravel deposits laid down by multiple receding glacial lobes. The aquifer has a high transmissivity. Very highly conductive gravel units exist and may dominate the transport of groundwater contamination. Scattered deposits of clay, some of great thickness, are also found in the study area. A locally continuous clay aquitard exists in the northwest portion of the study area, as shown by water well logs, but over the bulk of the study area, this aquitard is discontinuous or absent.

According to current information, groundwater flows from south to north across the study area. The aquifer discharges to the St. Joseph River.

The aquifer is terminated by a shale aquiclude, the Devonian/Mississippian Ellsworth Shale, at a depth of about 150 to 200 feet below ground surface in the study area.

REFERENCES

Chirlin and Associates, Inc. (1996) "Assessment of Contaminant Migration in Ground Water from Conrail to the Rivershore Peninsula", prepared for the U.S. Department of Justice, Environmental Enforcement Section, Washington, D.C.

Ecology and Environment, Inc. (1994) "Remedial Investigation/Feasibility Study, Conrail Site, Elkhart, Indiana, Remedial Investigation Report, Vol. 1 of 2", prepared for the U.S. Environmental Protection Agency, Region V, Office of Superfund, Chicago, Illinois.

Indiana Department of Natural Resources (1987) "Water Resource Availability in the St. Joseph River Basin, Indiana", Water Resource Assessment 87-1.

Indiana Department of Natural Resources (2007a) Water Well Records, retrieved from http://www.in.gov/dnr/water/ground_water/well_database/ .

Indiana Department of Natural Resources (2007b) Water well locations GIS layer, retrieved by Lorraine Wright, Indiana Dept. of Environmental Management, Office of Land Quality.

Indiana Geological Survey (2007a) A GIS Atlas for Indiana, accessed via http://129.79.145.7/arcims/statewide_mxd/index.html .

Indiana Geological Survey (2007b) iLITH database: clay thickness, accessed via http://129.79.145.7/arcims/statewide_mxd/index.html .

United States Geological Survey (1981) "Hydrologic and Chemical Evaluation of the Ground-Water Resources of Northwest Elkhart County, Indiana", Water-Resources Investigations Report 81-53.

United States Geological Survey (1992) "Hydrogeologic Atlas of Aquifers in Indiana", Water-Resources Investigations Report 92-4142.

United States Geological Survey (1994) Elkhart Quadrangle, Indiana, 7.5 Minute Series Topographic Map, revised from 1961 original, DMA 3867 III NW-Series V851.

Wayne, William J. (1956) "Thickness of Drift and Bedrock Physiography of Indiana North of the Wisconsin Glacial Boundary", Indiana Dept. of Conservation, Geological Survey, Report of Progress No. 7.

APPENDIX

Screened Intervals for Wells

The following table gives the depths of the screened interval for the wells in the study area, along with ground surface elevations where these are specified in IDNR (2007a). These records are sometimes incomplete and sometimes self-contradictory. Where the record conflicts with itself or is known to conflict with another source of data, question marks are added. Discrepancies of 1 foot or less are not marked.

All wells in T. 37 N, R. 5 E, Section 7 are included in the table, even those north of the St. Joseph River. Only wells from the northern half of Section 18 are included.

ID number	Ground elevation (feet above MSL)	Screened interval (feet below ground surface)
Section 7		
46743		40-45
46753		33-38
60276	750 (?)	99-103
60281	745	43-53
60286	780 (?)	32.25-36.25 ? 37.25-41.25 ?
60291	750	40-45
60296	753	42-48
60301	753	48-54
60306	726	98-103
60311	745	58-64
60316	744	59-62
60321	754	?-145
60326	754	91-111
60331	750	18-22 ? 34-38 ?
60920	798	22-26
60925		40-44
60930		34-38
60935		41-45

ID number	Ground elevation (feet above MSL)	Screened interval (feet below ground surface)
60940		39-43 ?
60945		31-35 ?
60950		26-30
60955		44-50
60960		50-54
60965		30-33.5 ? 32.5-36 ?
60970		22-26
60975		37-42
60980	754	95-125
60985		36-40
60990	"460" (760?)	48-58
60995	759	41-45
119656		86-89
132578		40-50
159032		Not screened, test hole?
159041		125-150
244262		53-57
246365		64-70
266519		38-43
277023		No data; abandoned well?
301693	725	8.5-13.5 Well use "other"; this well is very likely not a water supply well
325682	725	45-50
345085		50-57
347211		43-48
351423		31-51
352750		58-63
378988		88-108

ID number	Ground elevation (feet above MSL)	Screened interval (feet below ground surface)
Section 18		
5817		46-52
47489		35-40
60279	760	46-50
60280	760	46-50
60284	761	91-101
60285	755	68-89
60289	761	56-60
60290	755	70-89
60294		? -31
60309	755	31-35
60314		33-38
60319	762	51-61
60324	755	18-24 ? 40-46 ?
60339		66-70
60344		40-44
60364		40-44
60369		39-43
60393		29-33

Wells 60331 and 60324 are presumably screened at the lower indicated intervals; the higher interval is based on a reported casing length of 18 feet, which does not agree with the length of screen and total depth of the well. Excluding well 301693 as well, for the reasons stated in the table, the shallowest water wells (60920, 60970) in the IDNR records database are screened from 22 to 26 feet below ground surface. The deepest well (159041) is screened from 125 to 150 feet below ground surface.

Figure 1 - Clay Thickness

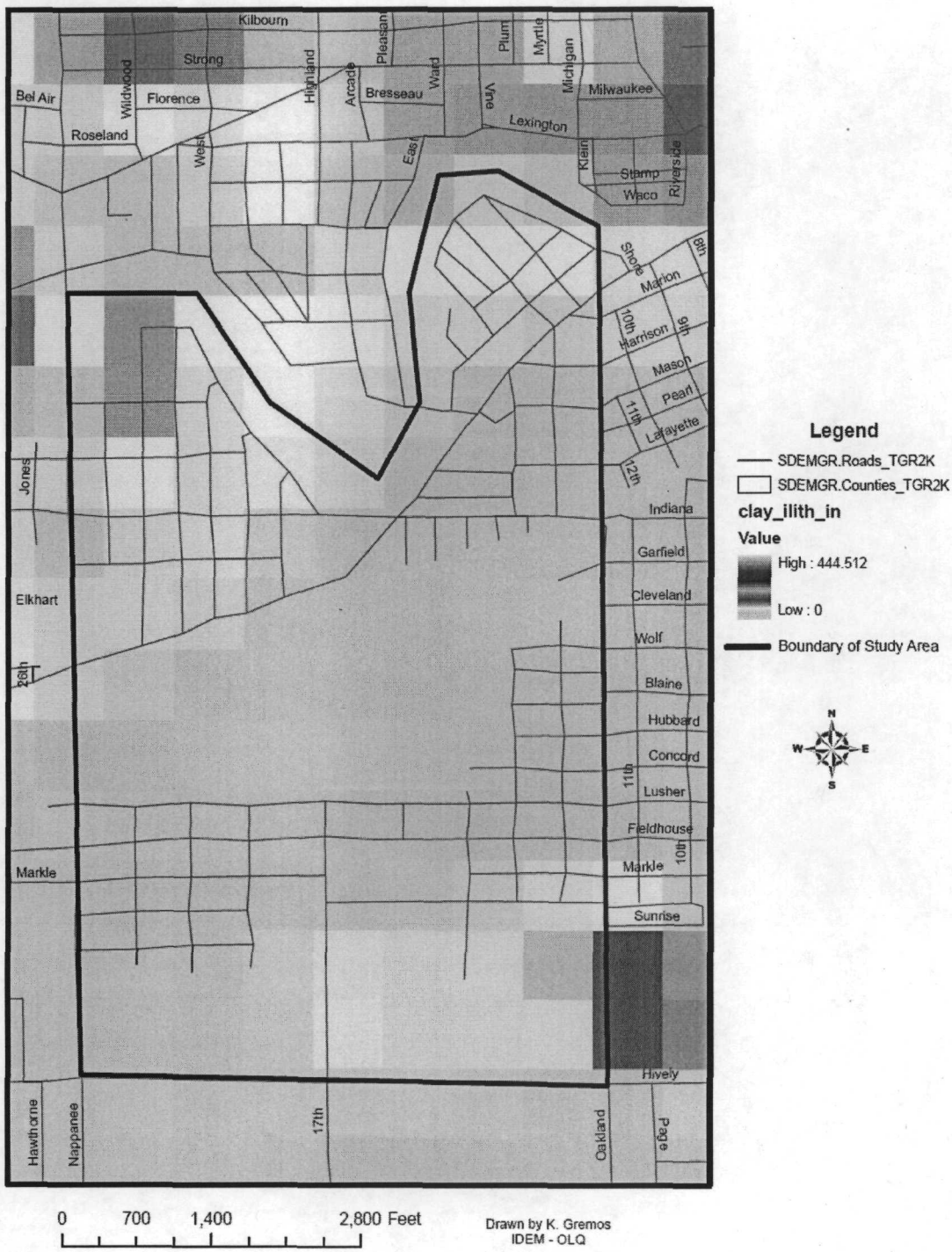


Figure 2 - Cross Sections

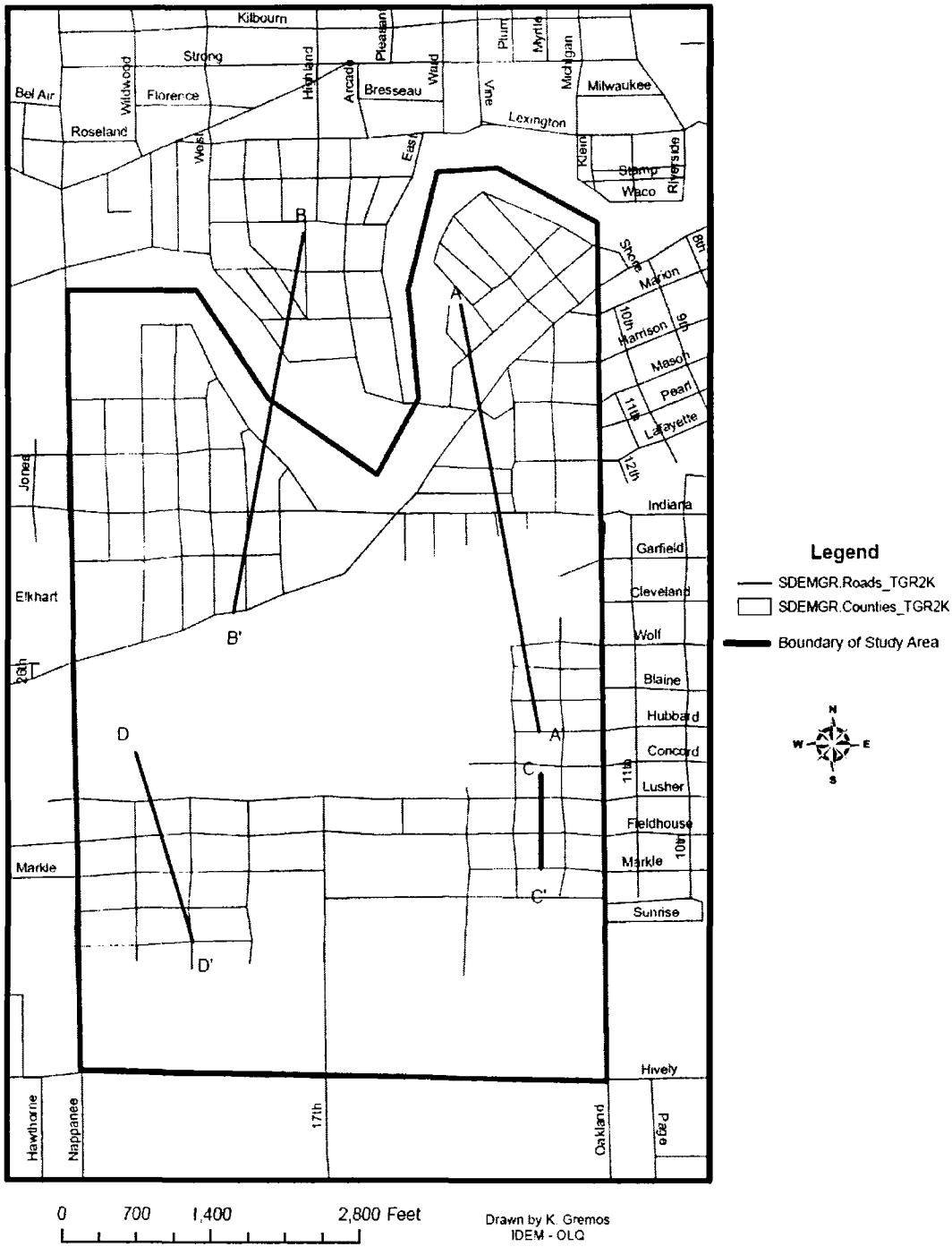


Figure 3 – Cross-Section A-A'

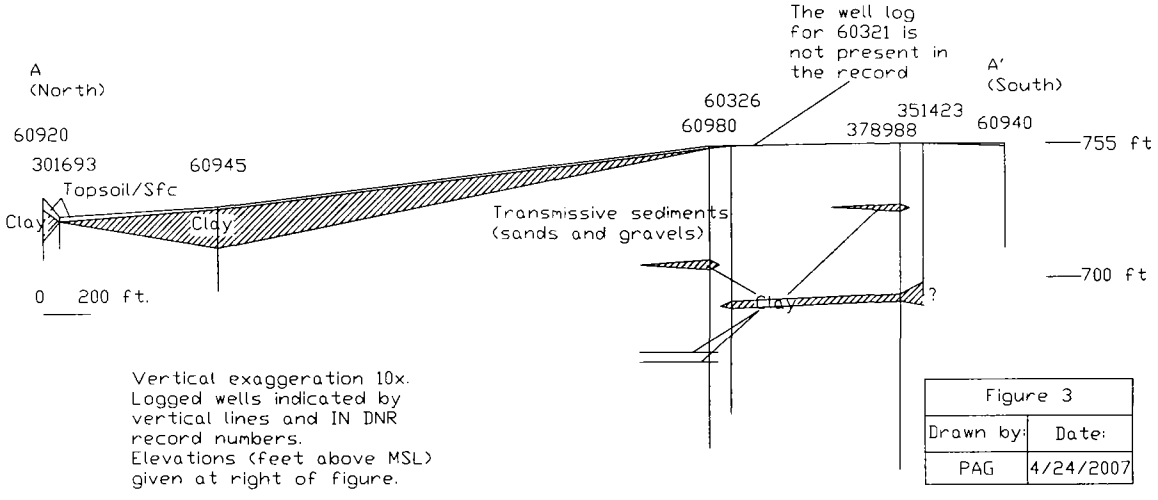


Figure 4 – Cross-Section B-B'

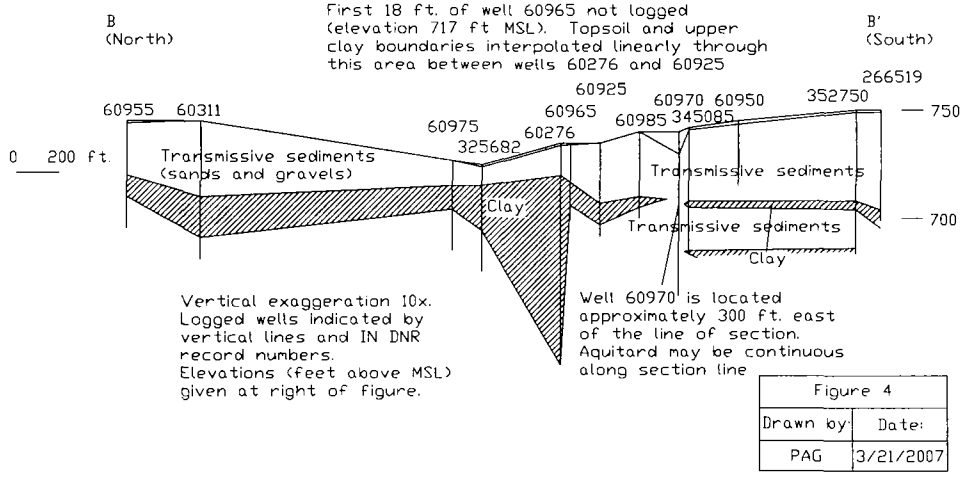


Figure 5 – Cross-Section C-C'

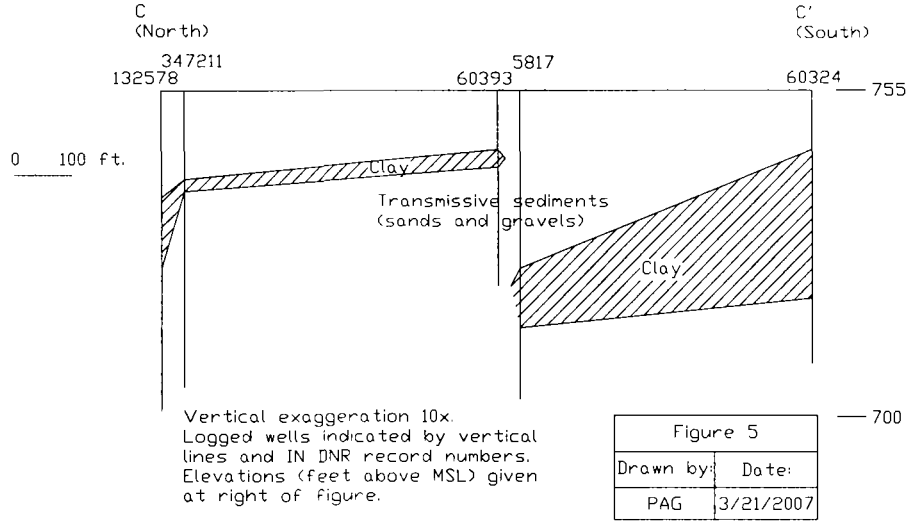


Figure 6 – Cross-Section D-D'

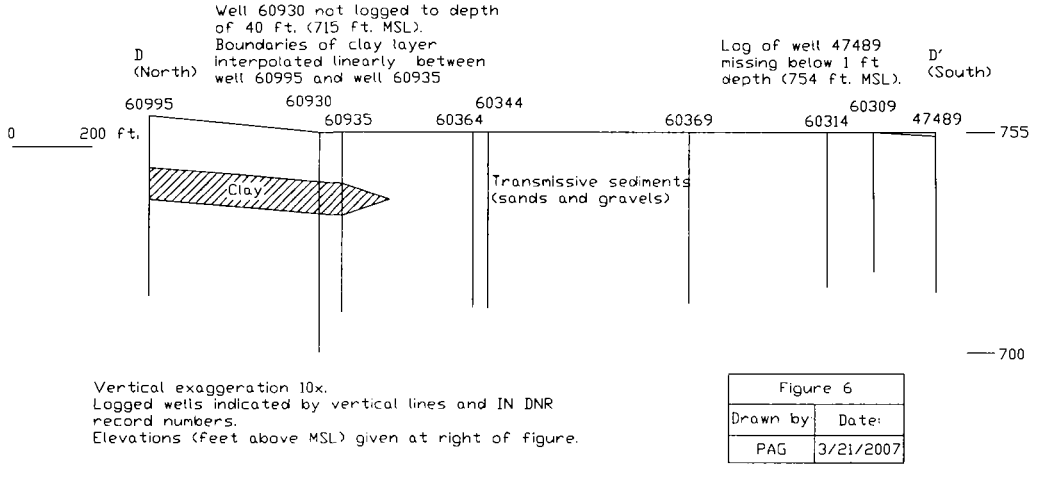
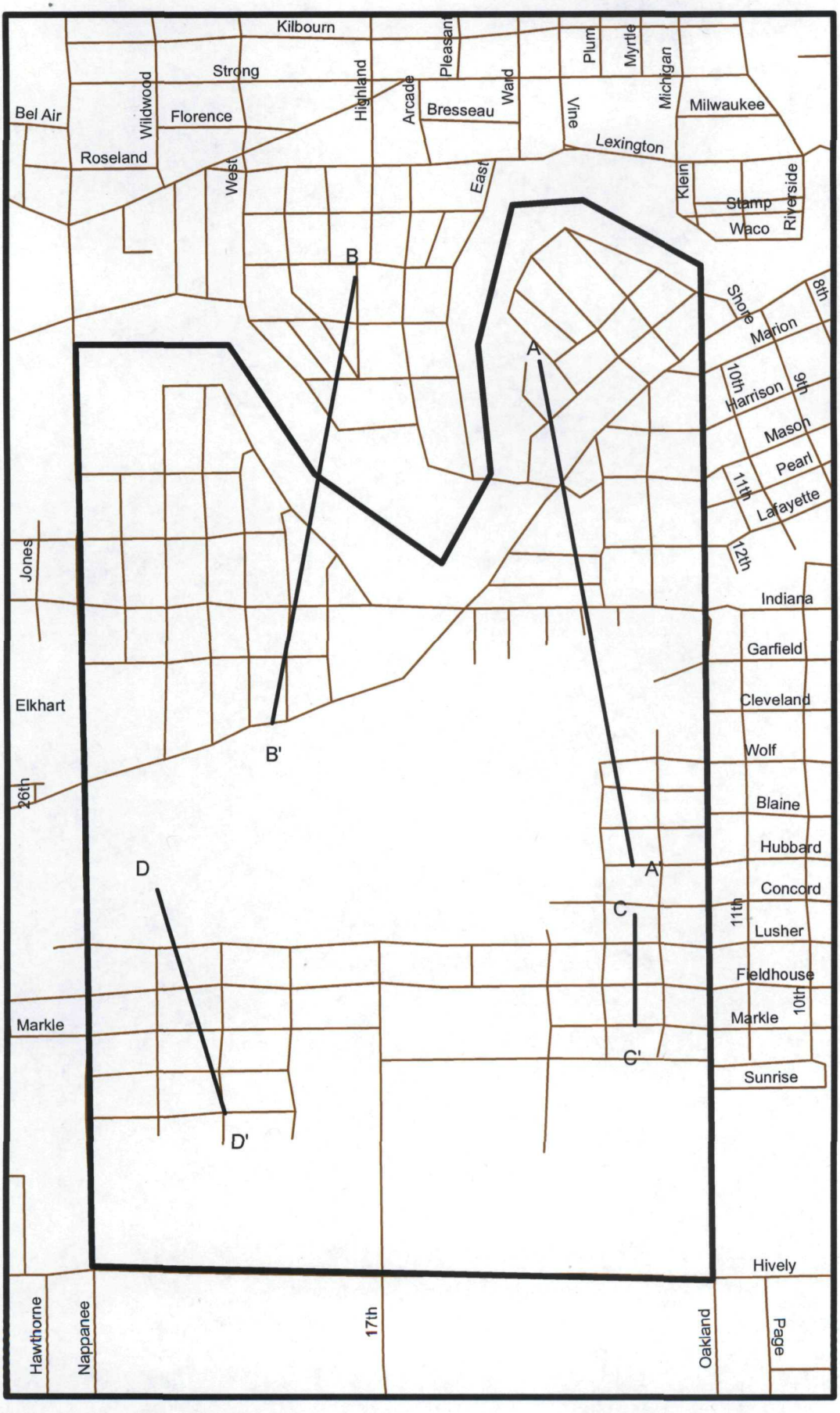


Figure 2 - Cross Sections



Legend

- SDEMGR.Roads_TGR2K
- SDEMGR.Counties_TGR2K
- Boundary of Study Area

N
W E
S

0 700 1,400 2,800 Feet

Drawn by K. Gremos
IDEM - OLQ

Figure 1 - Clay Thickness

Legend

- SDEMGR.Roads_TGR2K
- SDEMGR.Counties_TGR2K

clay_ilith_in

Value

High : 444.512

Low : 0

Boundary of Study Area

N W E S

0 700 1,400 2,800 Feet

Drawn by K. Gremos
IDEM - OLQ

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